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## The effects of alcohol based cues virtual reality versus guided imagery

Nicole Labriola  
*University of Central Florida*

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THE EFFECTS OF ALCOHOL BASED CUES:  
VIRTUAL REALITY VERSUS GUIDED IMAGERY

by

NICOLE LABRIOLA

A thesis submitted in partial fulfillment of the requirements  
for the Honors in the Major Program in Psychology  
in the College of Science and in  
The Burnett Honors College at the University of Central Florida  
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Thesis Chair: Dr. Jeffrey Cassisi

@2011 Nicole Labriola

## **ABSTRACT**

The use of Virtual Reality (VR) and Imagery have been utilized in psychological practices and treatment. VR has recently been the focus of research with treatments for post traumatic stress disorder, substance abuse, and phobias, among other social and behavioral issues. VR allows the researcher to create realistic controlled environments in which they are able to manipulate the experiment. Imagery permits the individual to imagine and recall scenarios from their past in order to create a more personal environment. This experiment aimed to expand upon VR practices and treatment in regards to alcohol research. In this experiment, 70 participants, 39 females and 31 males, were exposed to two VR alcohol and two Imagery alcohol cue environments. Subject craving and psychophysiological measures were taken across all four scenes and all baselines. Overall, craving measures demonstrated that female nondrinkers developed higher cravings during Imagery. Conversely, male social drinkers demonstrated higher cravings during VR. This study supports the use of VR environments in the study of alcohol cue reactivity.

## **ACKNOWLEDGEMENTS**

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## **INTRODUCTION**

According to the DSM-IV-TR, individuals who have repeated alcohol related problems suffer from either alcohol abuse or alcohol dependence (Kring, Davison, Neale, Johnson 2009). Alcohol abuse is more common and less severe than alcohol dependence, which is also known as alcoholism. There are established criteria for alcohol abuse. The criteria includes failure to fulfill major work, school, or home duties, driving under the influence, having reoccurring legal problems due to alcohol, and continued drinking even when there are ongoing relationship problems (Kring, Davison, Neale, Johnson 2009). If one or more of these occur within a 12 month period the individual is diagnosed as suffering from alcohol abuse. The more severe diagnostic category is alcohol dependence, which is a chronic disease defined as continuing to consume alcohol at a level that affects physical and mental health within family, life, and which significantly affects social responsibilities.

Individuals who are dependent on alcohol continue to drink despite these severe consequences. Those who develop alcohol dependence develop a tolerance in which they need to drink more in order to get the desired results. Those dependent on alcohol go through withdrawal when they stop consuming alcohol. During this time they will most likely experience through physiological and psychological consequences. The most severe level of withdrawal is termed delirium tremens which occur when an individual's blood alcohol level drops suddenly and leads to deliriousness, tremulousness, and visual hallucinations (Kring, Davison, Neale, Johnson 2009). There is a relatively low probability that people with alcohol abuse will progress to alcohol dependence (Kring, Davison, Neale, Johnson 2009).

Genetics as well as environmental factors greatly influence substance abuse. Substance abuse problems are found in anyone across gender and race. According to Kring et al. (2009), it has been established that white adolescents and adults are more likely to abuse alcohol than African Americans. Equally as noteworthy is that binge drinking is lowest among Asian Americans, while the highest incidence of alcohol dependence falls to Native Americans and Hispanics (Kring, Davison, Neale, Johnson 2009). About 14 million people in the United States are dependent on alcohol and it is more frequent in men than women. Also, it has been established that alcohol problems are highest among the ages 18-29 and lowest in adults 65 and older. Additionally, studies have shown that individuals who begin consuming alcohol at a younger age are more likely to develop alcohol abuse and dependence (Kring, Davison, Neale, Johnson 2009).

There are short term and long term consequences of excessive alcohol consumption that can lead to significant health issues later in life. Alcohol affects the nervous system. It stimulates GABA receptors, which helps to reduce anxiety and tension, much like prescription drugs such as Valium (Kring, Davison, Neale, Johnson 2009). Additionally, alcohol helps to increase dopamine and serotonin, which are pleasure receptors involved with the reward systems of the brain (Kring, Davison, Neale, Johnson 2009). Alcohol slows psychomotor speed due to its impact on the brains glutamate receptors; blocking glutamate receptors can lead to memory loss and other issues (Kring, Davison, Neale, Johnson 2009).

Continuous high alcohol consumption can lead to detrimental health issues. Malnutrition in particular is an important issue that is associated with long-term effects of alcohol. When an individual consumes alcohol there are few nutrients present in the calories. Also, due to the effects of chronic ingestion alcohol a person's digestive system becomes less capable of

absorbing vitamins and food. Alcohol consumption can also lead to a deficiency of B vitamins, cirrhosis of the liver, damage to the endocrine glands and pancreas, heart failure, erectile dysfunction, hypertension, stroke, capillary hemorrhages, and destruction of brain cells (Kring, Davison, Neale, Johnson 2009).

### Significance of Alcohol Abuse in Young Adults

The culture in which we live encourages the regular consumption of alcohol. To many, underage drinking is not considered a serious issue. For most adolescents obtaining alcohol is not a challenge. In fact, about half of all high school seniors report consuming alcohol during their senior year of school (Hingson, Heeren, Zalocs, Wechsler, 2002). According to Hingson, et al. (2002), 80 percent of college students drink and half of them report binge drinking; binge drinking means having 5 or more drinks at a time that often leads to dangerous situations and circumstances. On first glance however, occasional excessive drinking does not seem like an activity with serious consequences, there is evidence to the contrary. Excessive underage drinking leads to injury, assault, date rape, unwanted pregnancy, problems with school, damage to property, and death (Kring, Davison, Neale, Johnson 2009). Each year about two million college students drink and drive, while 1400 die every year from alcohol-related injuries. Furthermore, 25% of college students report that alcohol has negatively affected their performance in school ranging from absences to withdrawal (Hingson, Heeren, Zalocs, Wechsler, 2002). Additionally, binge drinking is highest between the ages of 18 and 25, peaking at 22 (Kring, Davison, Neale, Johnson 2009).

Clapp et al. (2009), studied 838 young adults using observational data, survey data, and breath samples to estimate blood alcohol concentrations from patrons attending 30 different bars. They recorded the participants drinking intentions and characteristics prior to going to the bar.

Three hundred and two participants had intentions of getting “a little drunk”, 257, “a slight buzz”, and 133 “very drunk”. Only 27 people did not intend to drink and 55 said they did not intend to “get buzzed.” Interestingly, these same researchers found that 53% of underage students and 86% of legal drinking age students attended a bar in the last month, with over a third in each group reporting five or more drinks.

There is evidence that the prevalence of alcohol among college students on campuses is increasing annually (Hingson, Heeren, Zalocs, Wechsler, 2002). Thus, it is important for students to protect themselves and learn the dangers of underage drinking and drinking at any age. Some have advocated the view that drinking behavior is a skill in which young adults have to learn appropriate levels and control (Baer, Fromme, Kivlahan, and Marlatt 1994).

### Cue Reactivity and Drinking

Cravings for alcohol have been assumed to be a feature of drinking behavior within the addictions field. Rush (1789) was one of the first to suggest that environmental cues can elicit craving and drinking. Wikler (1948) subsequently theorized that specific drug cues existed and they play an important role in morphine addiction for both animals and humans. This process is now termed “cue-reactivity” and it has been applied to many areas of substance use and abuse.

Cue reactivity is based on classical conditioning theory (Pavlov, 1927; Tiffany, 1995).

According to the classical conditioning theory, virtually any response to cues can be conditioned by environmental stimuli such as people, places, or situations related to past alcohol use (Childress et al., 1993; O'Brien, Childress, McLellan, & Ehrman, 1993; Prakash & Das, 1993; Satel, 1992; Wallace, 1989; Washton, 1987). Following this logic complex stimuli, over repeated association with pleasurable events, such as alcohol intoxication, can become

conditioned stimuli, are capable of eliciting conditioned responses such as craving, skin conductance, and heart rate.

Figure 1 illustrates the Cue Reactivity Model of Drinking Behavior in which environmental stimuli lead to cue reactivity which in turn leads to consumption. This model posits cues which have been associated with drinking behavior can elicit cravings and physiological responses that leads to consumption (behavior). Cue reactivity research typically involves exposing participants to a cue and then observes the associated self report, physiological, and behavioral responses (Drummond 2000). The sight, smell, and taste are commonly studied exteroceptive cues (Drummond 2000). These are termed *in vivo* cues since they occur as “in life”. Sometimes visual cues, such as showing the participants favorite drink is used, or the sight of a bar scene or advertisement have been studied. Cue reactivity in experimental studies have often found that self-reported craving is greater than physiological effects (Carter & Tiffany, 1999). The type of cues that elicit craving vary from person to person and they are considered a phasic response, according to Drummond (2000). Furthermore cues that are more salient are thought to produce a greater level of reactivity in the three response domains.

Various researchers have studied alcohol cue reactivity using *in vivo* stimuli and simple cue presentations. For example, Pomerleau, Fertig, Baker, and Cooney (1983) compared the psychophysiological responses of 8 alcoholics in treatment with 10 alcoholics not in treatment using the smell of a favorite alcoholic beverage and cedar chips. Results suggested that swallowing and salivation were significantly elevated in alcohol-sniffing trials for alcoholics in treatment. Later studies using similar procedures have consistently found increases in salivation

and skin conductance in response to the sight and smell of alcohol in alcoholics (Glautier & Drummond 1994; Payne et al. 1992; Staiger & White 1991).

Monti and Rohsenow (1999) reported that relapse can be brought about by a variety of complex cues including mood state, social interactions, and drinking materials. For example, Kambouropoulos, Nicolas and Staiger, (2008) studied the role of reinforcement expectancies in relation to alcohol cue reactivity. They examined 61 social drinkers to conduct their study. The self-reported responses were measured following the presentation of the sight, smell, and taste of alcohol and comparing it to a control stimuli. They found that in vivo alcohol cues resulted significant increases in the self-reported urge to drink.

Several studies have examined psychophysiological responding to pictures of alcohol beverages to determine whether the cue reactivity model generalizes to these stimuli as well (Cassisi et al, 1997; Eriksen & Gotesom 1984; Laberg et al.1992; Stomark, Laberg Bjerland, & Hugdahl 1993). In one study, Laberg et al. 1992 found that 83 alcohol-dependent subjects demonstrated significantly greater skin conductance responses to alcohol-related slides than to control slides. In a second study using a control group design, however, Stomark, Laberg Bjerland, & Hugdahl 1993 did not find a cue-specific response to alcohol slides. In this latter study, 20 alcohol-dependent subjects responded with increased skin conductance levels to both alcohol-related and neutral slides relative to the 20 control subjects. They concluded that the alcohol-dependent subjects demonstrated a nonspecific pattern of hyper reactivity rather than a cue-specific one. Therefore, the previous findings are inconclusive as to whether visual stimuli such as pictures serve as a cue for urges to drink and craving. Clearly, additional research is needed.

Another study examining complex cognitive and emotional of cues related to drinking urges was recently reported by Drobles, Carter, & Goldman (2009). They were interested in how alcohol expectancy measures related to indices of cue reactivity among young adult drinkers. They divided 55 participants between the ages of 18 and 28 into low and high drinkers, via median split. Subjective and psychophysiological measures of cue reactivity and the startle eye blink reflex were measured during picture cue presentations. The data indicated that, “participants who reported greater positive, arousing, and social alcohol expectancies rated alcohol cues as more pleasant, arousing, craving inducing” (Drobles, Carter, & Goldman 2009). They concluded that all participants displayed, “inhibited startle reactivity to alcohol cue probes, indicative of an appetitive reaction” (Drobles, Carter, & Goldman 2009). Additionally, the participants with greater alcohol expectancies displayed more attention to negative affect cues. The individuals with the greatest social expectancies of alcohol consumption rated alcohol cues as more pleasing, arousing, and crave inducing.

Mason et al. (2008), studied independent and interactive effects of both positive and negative affective stimuli and beverage cue on psychophysiological and subjective measures of reactivity in alcohol dependence. In order to measure the response they exposed 47 participants to a standardized set of pleasant, neutral, or unpleasant visual stimuli and then followed it up with water and alcohol cues. Throughout the experiment they measured heart rate, skin conductance, and facial electromyography while presenting picture cues to the participants. They established that positive affective stimuli commonly associated with drinking situations can induce craving in the absence of alcohol cues. This led the researchers to conclude that positive affective stimuli usually associated with drinking situations by themselves, is capable of inducing craving in the absence of alcohol cues.

Guided imagery also has been used in the study of cue reactivity. A study by Cooney et al. (1997) examined whether reactivity to alcohol cues or reactivity to negative moods caused alcoholics to relapse after treatment in men. In order to determine this, the researchers required the participants to go through guided imagery that was designed to induce negative moods and they were then exposed to their personal favorite alcoholic beverage or water. The results demonstrated that being shown the alcoholic beverage as well as being presented with the negative imagery scene created an increased desire to drink among the participants. They concluded that negative imagery can cause craving.

These recent studies demonstrate that a variety of stimuli across settings can elicit cue reactivity and alcohol craving. These studies strongly suggest that the presence of cues in the environment elicit urges to drink.

### Virtual Reality and Cue Reactivity

Virtual Reality has gained clinical acceptance for phobias, pain, eating disorders, and post-traumatic stress disorder (Anderson, Rothbaum, & Hodges, 2001). VR is also currently being used for the treatment of psychological disorders, because when participants are immersed in VR they report emotional and psychological arousal (Muhlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001). Since VR treatment can lead to increases in functional activities in everyday life, it can provide beneficial tools for recovery (Rizzo, Wiederhold, & Buckwalter, 1998).

As stated, Marlatt and his colleagues (Baer et al. 1994) have advocated a skills training approach to alcohol treatment. Niaura (2002) argues that coping skills need to be acquired and practiced in contexts that are congruent with real world environments where alcohol use occurs.



Virtual Reality may provide a technology to provide a convenient cue exposure method. Thus VR shows potential in advancing treatment and research in the addictions area.

By using VR researchers are able to create realistic controlled environments in which they can accurately assess what the participant is witnessing as well as manipulate the constructs of what they want to include in the study. A major advantage of VR is that it is a controlled environment, yet realistic to the participant. Branislav, (2011), cited the following as benefits of VR:

- Cost Effectiveness - Stimuli which can be difficult to control are both expensive and time consuming. For example, exposure to stimuli, such as airplanes and driving can be expensive. Thus, using virtual reality individuals are able to be exposed to flying or driving without leaving the clinic or controlled situation.
- Treatment Effectiveness - VR can provide the stimuli for patients who are not capable to imagining the stimuli. Furthermore, this is accomplished with privacy and confidentiality. In Virtual settings the therapist has more control over the situation and therefore the stimuli can be titrated to increase efficiency.
- Patient Acceptance - According to various surveys individuals are more willing to participate in a virtual reality environment than a real physical one in terms of treatment.

VR has been contrasted with in vivo cues for several commonly abused substances in order to determine the relative effectiveness of both procedures for practice. Bush (2007), exposed 33 participants to a gradual increase of feared stimuli, to test the effectiveness of the gradual exposure in the treatment of phobia. The responses were measured through behavioral assessment tests, self-evaluation, blood pressure and heart rate in order to reduce anxiety and to

compare virtual reality and in vivo. The researchers termed this approach Virtual Reality Exposure Therapy (VRET). Results demonstrated that virtual reality exposure is cheaper than and as effective as in vivo. The authors predict that as VRET is developed, it will have a significant impact on clinical practice and research.

Although, not dealing with drinking behavior one study has examined cue-reactivity in relation to other commonly abused substances. This study involved cue reactivity and young marijuana smokers (Gray, LaRowe, and Upadhyaya 2008). They observed the physiological responses to marijuana cues via imagery, video, and in vivo methods (showing them a “joint” and a lighter) and showing them neutral cues (a pencil and eraser). Subject craving using the Marijuana Craving Questionnaire as well as asking the participant on a scale of 0-20, “how much do you want to smoke right now,” was used before and after every cue presentation. Heart rate and skin conductance were also measured before, during, and after cue presentation. The researchers concluded that there were higher levels of craving during the imaginary marijuana cues. This research shows that because cue reactivity elicits self-reported responses in imagery more than in vivo, it stands to reason that imagery would also be more effective than virtual reality. However, more research applying virtual reality and alcohol are needed.

The thesis research presented here directly replicates and extends Bordnick et al. (2008). In Bordnick et al. (2008), a VR alcohol cue reactivity assessment was conducted that incorporated visual, auditory, and olfactory stimuli. Participants were 40 non-treatment-seeking drinkers with alcohol use disorders exposed to VR alcohol cue environments. They assessed subjective craving ratings, attention to alcohol cues, and level of presence in VR environments. Results showed that alcohol craving significantly increased across the VR alcohol related cue environments versus VR neutral cue environments. Participants reported high levels of presence

in VR, indicating that the environments were realistic. This research helps support the use of VR environments for use in alcohol cue-based treatment and research.

The objective of this study is to compare cue reactivity to virtual reality alcohol stimuli as conducted in Bordnick et al. (2008), and to compare VR with traditional guided imagery. Additionally, this study will incorporate psychophysiological measures of craving and cue reactivity which was not done in the Bordnick et al. (2008) study. Given the putative advantages of VR reviewed above, it is hypothesized that VR will produce greater self-reported craving and physiological responses than guided imagery. Specifically it is hypothesized that social drinkers will demonstrate greater self-reported craving, heart rate, skin conductance level, and skin conductance rate during VR as contrasted to guided imagery.

## **METHOD**

### **Participants**

Participants were 70 individuals enrolled in psychology courses as undergraduates at the University of Central Florida. There were 39 females and 31 males. The participants were 7.1% African American, 11.4% Asian, 15.7% Hispanic, and 65.7% Caucasian. The mean age of males was 23.9 years (SD=6.24). The mean age of females was 23.6 (SD=5.4). No participant met the criteria for alcohol dependence and one met the criteria for alcohol abuse. Participants were required to sign up for the study through an online system. Participants had to be at least 21 years old in order to participate in the experiment. Participants were excluded if they were undergoing medical treatment or on medication. The participants received course credit for their participation.

### **Measures**

**Demographics Questionnaire.** The Demographics Questionnaire was used to collect the participant's age, gender, height, weight, nationality, employment, and drink preference. Participants were also asked if they were currently receiving psychiatric treatment and if they were on any medications, (see Appendix A for Demographics Questionnaire).

**Michigan Alcohol Screening Test (MAST).** The MAST was originally developed using responses from men convicted of driving under the influence of alcohol and has been further refined since. The instrument contains 25 true false items about alcohol use. It takes approximately 10 minutes to complete (Selzer 1971). Items are scored of 0, 1, 2, or 5 points with a range of total scores 0-53. Hood and Johnson (2007) reported that most frequently used interpretation method is to consider a total score, or the sum of all individual items' point. A

score of 5 or more is suggestive of alcohol use, and 12 or more is suggestive abuse. Test-retest reliability estimates have been reported on inpatient psychiatric and nonclinical samples as  $r=.95$  and  $r=.98$  respectively for 7-day retest interval (Teitelbaum & Carey, 2000). Previous investigations of the MAST report a false-positive rate of 33% (Jacobson, 1983) and an overall accuracy of about 75% (Creager, 1989). (See Appendix B for the MAST).

Timeline Follow-Back (TLFB). The TLFB is an interview technique that assists respondents to quantify and report their recent drinking. Results have been shown to have greater validity than do questionnaire items about one's usual quantity and frequency of drinking (Sobell and Sobell, 1992; Sobell et al., 1988). In the TLFB, the interviewer and respondent review a calendar marked with dates that are memorable for the community (e.g., homecoming) or the individual (e.g., an anniversary). Respondents are then asked to report the amount of alcohol consumed on each day, and this is recorded as the number of standard drinks. A standard drink is defined as 12 ounces of beer, 5 ounces of wine or 1.5 ounces of distilled spirits. Several studies have compared the TLFB against daily concurrent self-reports from diaries or telephone calls. Perrine et al. (1995) obtained a correlation of 0.51, between the total number of drinks reported over 28 days by daily phone calls with a self-administered TLFB. Carney et al. (1998) reported correlations of 0.80 to 0.97 between various consumption variables and daily self monitoring. The TLFB time frame used in this study was the number of drinks consumed each day in the 14 days before the day of interview. (See Appendix C for TLFB).

Alcohol craving. A craving scale was used to measure subjective craving for alcohol. After each scene the participant was asked to rate their current level of craving by answering the

question, “On a scale from 0 to 10, 0 being none at all and 10 being more than ever, how much are you craving alcohol right now?”

Psychophysiological Measures. The Psychophysiological measures were collected through the BIOPAC MP150 system and AcqKnowledge data acquisition software (BIOPAC Systems, Inc., Crystal Bay, NA). Physiological measures were collected every second throughout the baseline and experimental scenes. A Biopac PPG100C, photoplethysmograph module was used to measure heart rate. A Biopac GSR 100C module measured skin conductance levels and responses.

VR-Equipment. The VR equipment used was the Virtually Better, Inc. Decatur, GA. Subjects wore a VR head mounted display and tracker (HMD; VFX-3D, Interactive Imaging Systems, Rochester, NY) at all times.

VR-Environment. The neutral cue environment was a gallery of white walls and four aquarium scenes that featured video and sound. The bar cue environment featured a typical bar setting in which the participant watched an individual order and consume an alcoholic beverage. The participant was then asked by the virtual bartender for their drink and served it to them. The beverage was pre-selected by the participant. The kitchen environment consisted of a typical kitchen at a party. The counters were lined with alcohol related cues, such as blenders and mixers, as well as alcohol cues such as liquor and beer. The participants moved around the kitchen observing the various items. Figures 2, 3, and 4 illustrate the different VR environments used in this study.

Imagery. The imagery scripts used in this experiment were presented via mp3 recordings in order to ensure consistency. The imagery scenes verbally described the same scenes as were

presented in the VR phase. Participants were asked to imagine a Bar environment and a Kitchen environment for 90 seconds following the conclusion of the script. The scripts can be found in Appendix D.

### Procedure

An announcement for the study was placed on the Sona Systems website at the University of Central Florida. There participants were able to schedule a date and time to come in to complete the study. Once participants arrived they were required to complete demographical information (Appendix A) as well as the Michigan Alcohol Screening Test (Appendix B) and the Timeline Follow Back (Appendix C). All individuals who exhibited and met criteria for unsafe drinking habits and appeared to be suffering from either alcohol abuse or dependence, were given referral information in order to seek help and counseling, although no individual was clinically diagnosed by the researchers.

Upon completion of all the surveys and questionnaires all of the participants were asked to sit in the Virtual Reality chair. Then the researcher cleaned the participants' hand with a nonalcoholic baby wipe in order to get a clean read on the physiological equipment. Then the heart rate and skin conductance electrodes were attached to the participants following standardized placements as described in Andreasi (2007). Prior to the experimental phases all participants sat quietly for a five minute baseline. Participants wore the headgear throughout the baseline and experiment phases. The participants were presented VR or imagery phases in counterbalanced order. The Kitchen and Bar scenes were also counterbalanced within phases. After each scene and the initial baseline the researcher asked the participant, "On a scale from 0-

10, 0 being none at all, 10 being more than ever, how much are you craving alcohol right now”  
and recorded the answer. This was entered as the craving rating for that phase.



## RESULTS

The data analyzed in this thesis are based on the self-reported craving ratings. Time constraints precluded the analysis of the psychophysiological data. These will be included in the publication version of this study.

### Group Assignment

A frequency analysis was conducted on the TLFB totals drinks score by sex. A median split was conducted separately for females and males. The median number of drinks for females was 2.0. The median number of drinks for males was 3.0. Participants were assigned to the Group 1 (nondrinking) if they scored at the median or below for their sex. Participants who scored above the median were assigned to Group 2 (social drinking) for their sex. The median split resulted in 20 females being assigned to Group 1 (nondrinking) and 19 to Group 2 (social drinking), and 14 males being assigned to Group 1 (nondrinking) and 17 to Group 2 (social drinking).

### Craving

A 2 Group (non vs. social drinkers) x 2 Sex x 2 Phase (VR vs. imagery) x 2 Scene (bar vs. kitchen) MANOVA was conducted using the craving ratings. The last two factors were repeated (also referred to as within subjects factors). A significant Phase x Scene x Group x Sex interaction was obtained,  $F(1, 66) = 4.63, p = .04$ . A significant Phase x Scene x Group interaction was obtained,  $F(1, 66) = 5.69, p = .02$ . Lastly, a significant Phase x Group interaction was obtained,  $F(1, 66) = 5.12, p = .03$ . No other interactions or main effects were obtained.

A series of ad hoc pairwise comparisons were conducted to understand these significant effects. The average craving ratings from each group were compared with an independent

samples t-test during the VR Bar Scene. The ratings for Group 2 (social drinkers) were significantly higher than Group 1 (nondrinkers),  $F(1, 68) = 31.04, p < .001$ . The mean craving ratings during the VR Bar Scene are presented in Figure 5. The average craving ratings from each group were compared with an independent samples t-test during the VR Kitchen Scene. The ratings for Group 2 (social drinkers) were significantly higher than Group 1 (nondrinkers),  $F(1, 68) = 5.01, p = .028$ . The differences in these ratings are also illustrated in Figure 5. The average craving ratings from each group did not differ during either imagery scene.

Next, the imagery and VR phases were compared for Group 1 (nondrinkers) using a paired sample t-test. A significant difference was obtained when comparing the craving ratings following the VR Bar Scene and Imagery Bar Scene. Results showed that craving ratings were higher during the Imagery Bar Scene,  $t(33) = 3.04, p = .005$  for Group 1 (nondrinkers). No differences were obtained when comparing the kitchen scenes. The same comparisons were conducted for Group 2 (social drinkers) and no significant differences were obtained when comparing VR and Imagery. Figure 6 illustrates the difference between VR and Imagery Bar Scenes by group

An overall craving rating variable for VR was computed by adding together the craving rating for both VR scenes and this was termed the VR Craving Total score. Additionally an overall craving rating variable for imagery was computed by adding together the craving rating for both imagery scenes and this was termed the Imagery Craving Total score. The VR and Imagery Craving Total scores were compared via paired sample t-tests by group. The VR and Imagery Craving Total scores were compared via paired sample t-tests by sex for Group 1 (nondrinkers). The Imagery Craving total scores were significantly higher than the VR Craving total scores for the Group 1 (nondrinkers) females,  $t(19) = 2.13, p = .047$ . There was no difference

in the Imagery Craving total scores and VR Craving total scores for the Group 1 (nondrinkers) males. These differences are illustrated in Figure 7.

The VR and Imagery Craving Total scores were compared via paired sample t-tests by sex for Group 2 (social drinkers). The VR Craving total scores were significantly higher than the Imagery Craving total scores for the Group 2 (social drinkers) males,  $t(16) = 2.47, p = .026$ .

There was no difference in the Imagery Craving total scores and VR Craving total scores for the Group 2 (social drinkers) females. These differences are illustrated in Figure 8.

## DISCUSSION

The purpose of this study was to contrast the effectiveness of guided imagery and VR stimuli in the cue reactivity paradigm. These comparisons were also made separately by sex and for nondrinking and social drinking participants. Bordnick et al. (2008) found that VR alcohol cues elicited greater self-reported craving responses than VR non-alcohol cues. However Brodnick et al. (2008) did not contrast VR with other cue-reactivity methods. Since Wolpe's early work with systematic desensitization in the late 1950's and early 1960's, imagery has been relied upon in Behavior Therapy as a method for cue exposure. Since imagery approaches have a long history of use and have a much lower cost, it is an obvious method to compare with VR approaches to cue exposure.

Craving measures were compared in a MANOVA with cue presentation method (imagery vs. VR), scene (bar vs. kitchen), drinking group (nondrinking vs. social drinking), and sex (males vs. females) as factors. We obtained significant 2-way interaction between the cue presentation method and drinking group. Additionally we obtained a significant 4-way interaction between method, scene, drinking group, and sex. These significant interactions were explored with ad hoc ANOVAs and t-tests to understand their meaning and to test the hypothesis that VR would be more effective than imagery in eliciting craving.

Craving ratings were significantly higher for Group 2 (social drinkers) than Group 1 (nondrinkers) during both the bar and kitchen VR scenes. This is illustrated in Figure 5. There were no significant differences between the drinking groups during the two imagery scenes. It is not surprising that Group 2 (social drinkers) were more responsive to the alcohol cues since Group 1 (nondrinkers) most likely had little experience with consuming alcohol. Therefore,

Group 1 (nondrinkers) did not have the conditioning history needed to associate with the alcohol cues presented in the VR phase as did the Group 2 (social drinkers).

Group 1 (nondrinkers) reported significantly higher craving ratings during imagery for the bar scene than the VR phase. There were no significant differences in craving ratings for Group 2 (social drinkers) between imagery and VR bar scenes. This is illustrated in Figure 6. It stands to reason that Group 1 (nondrinkers) were capable of recalling narrow situations where they attended a bar and were able to personalize the imagery scene, while they may find the VR bar scene to be unfamiliar and perhaps unrealistic.

Females in Group 1 (nondrinkers) reported significantly higher craving ratings during imagery than the males in that group. Interestingly, males in Group 2 (social drinkers) reported significantly higher cravings during VR than the females in that group. These findings are illustrated in Figures 7 and 8. It is possible that it is a consequence of the increased familiarity and history with gaming environments in males as compared to females. Also, it is likely that females in Group 1 (nondrinkers) were able to create a more realistic environment through imagery since they had a less conditioning history associated with alcohol consumption. On the other hand, it is feasible that males in Group 2 (social drinkers) responded more to the VR phase, because they had a conditioning history to situations in which they consumed alcohol, either at a bar or party.

Taken together these results offer only partial support for the hypothesis that VR is more effective than imagery in eliciting cue reactivity. Nonetheless, these findings are important because they shed some light on the relative effectiveness of imagery and VR methods. Our findings indicate that in general, imagery was quite effective in eliciting self-reported craving

across most situations and with most individuals. This was especially true with males and females who were relatively naïve to alcohol use. Thus imagery is likely to be the most cost effective approach in this situation. An example would be an alcohol abuse prevention class conducted on a college campus with incoming freshman. Such a class might incorporate guided imagery of typical drinking situations to practice the drinking skills of self-monitoring and drink refusal. Virtual Reality was superior to guided imagery under more narrow conditions. Male drinkers responded with significantly greater cravings during the VR condition than during the imagery condition. Additional analyses are being conducted by other members of the research team to understand this effect.

While the cost of VR equipment may be an initial deterrent, it is important to recognize that modern technology is a constantly expanding and developing market in which new software is being created that can provide affordable solutions. Also, the possible long term benefits of VR are numerous. It offers decreased costs, since outside environments are not needed, nor are outside subjects. By using VR it eliminates the possibility of issues that are outside of the control of the experimenter or clinician when treating clients. It also provides a secure confidential environment that effectively elicits emotion, such as craving.

#### Limitations of study

The results of this study provide further proof that VR is an effective tool for treatment. However, limitations that arouse need to be taken into consideration and expanded upon in future studies.

The participants were undergraduate psychology students above the legal drinking age. While this data provided significant results certain factors should be recognized. Research

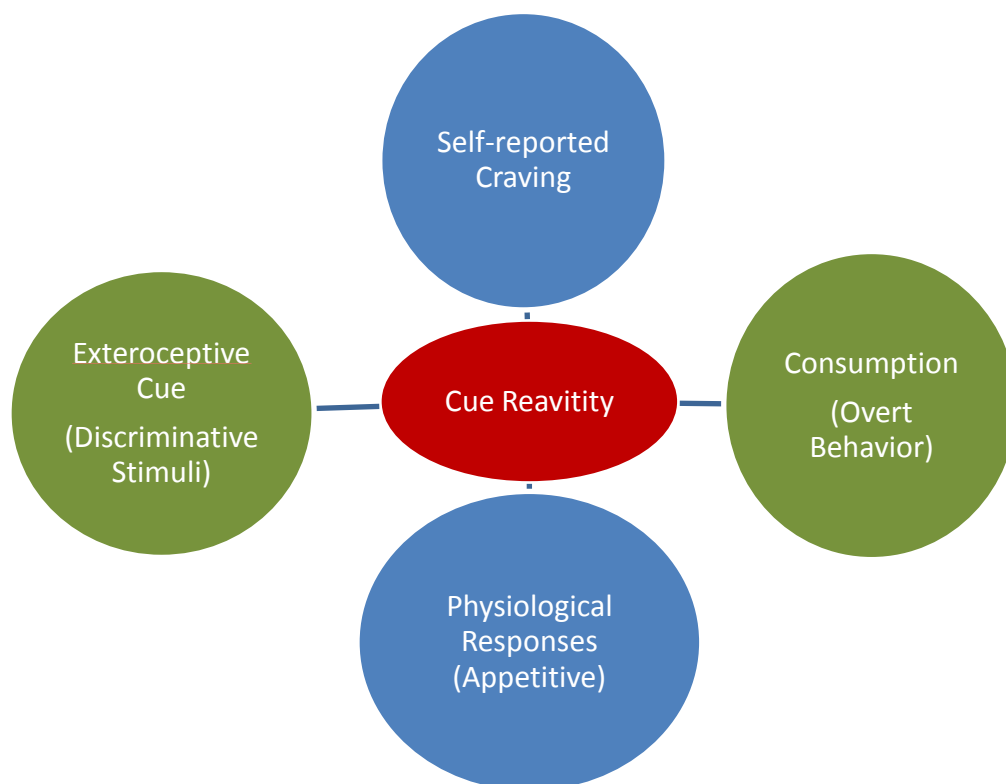
shows that binge drinking peaks at age 22 (Kring et al. 2009). The average age of male participants was 23.9 and the average age of female participants was 23.6. This may account for an increase in craving. Also, unlike Bordnick et al (2008) this study did not utilize the scent features of the program. This omission could have seriously attenuated craving responses. Bordnick (personal communication) has indicated that in his opinion smell is an essential component of the VR environment.

Participants were required to complete a demographics form in which they were asked to report drug use. Aside from common, over the counter drugs, no participants reported consuming any psychiatric or illegal substances. There is some question about their willingness to frankly disclose their substance use history in this situation. In future studies it may be beneficial to provide a drug screening test to determine recent smoking, alcohol, or other possible mood alternating substances and to either rule out confounding effects or to observe how they affect the craving response.

### Conclusions

In conclusion, this research shows that VR environments can be used to manipulate the subjective experiences of participants. The hope is that VR will eventually be proven to be effective in eliciting reactions similar to the real world or in vivo stimuli. Eventually VR methods will be developed that permits the individual to experience arousal to cue and to develop coping skills which can lead to changes in real life situations. Further research is needed in regards to treatment through VR environments. The results of this study provide a solid foundation for such research.

**FIGURE 1: Cue Reactivity Model of Drinking (Drummond, 2000)**





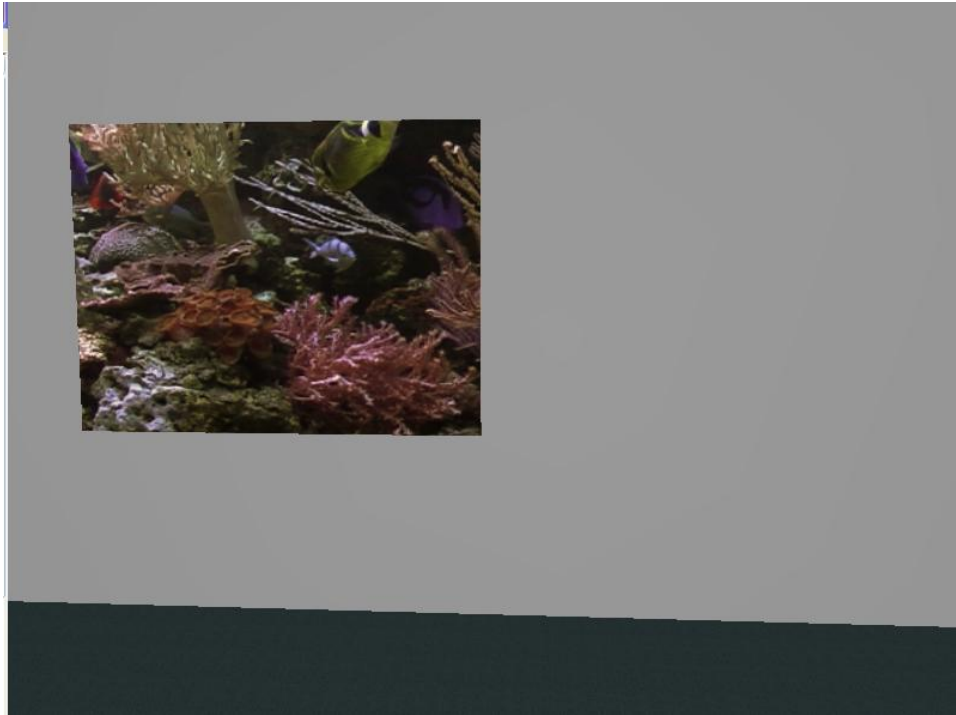
**FIGURE 2: Virtual Reality Bar Scene**



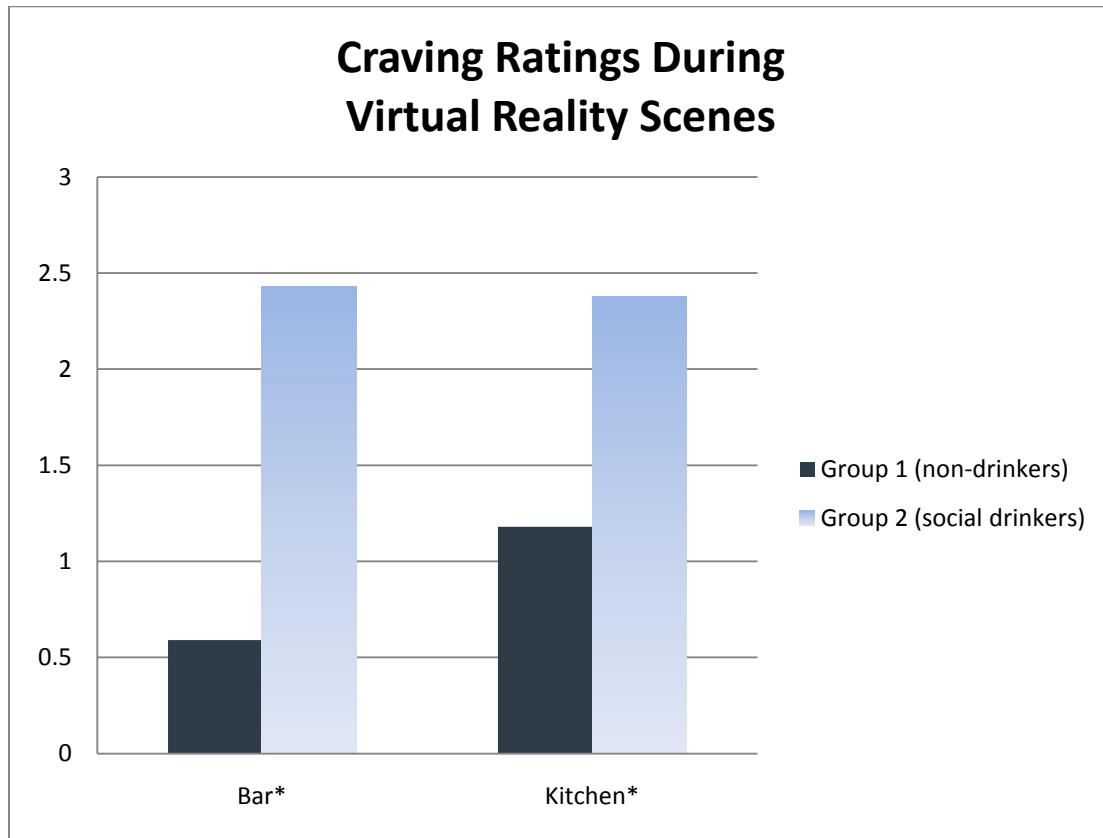
**FIGURE 3: Virtual Reality Kitchen Scene**



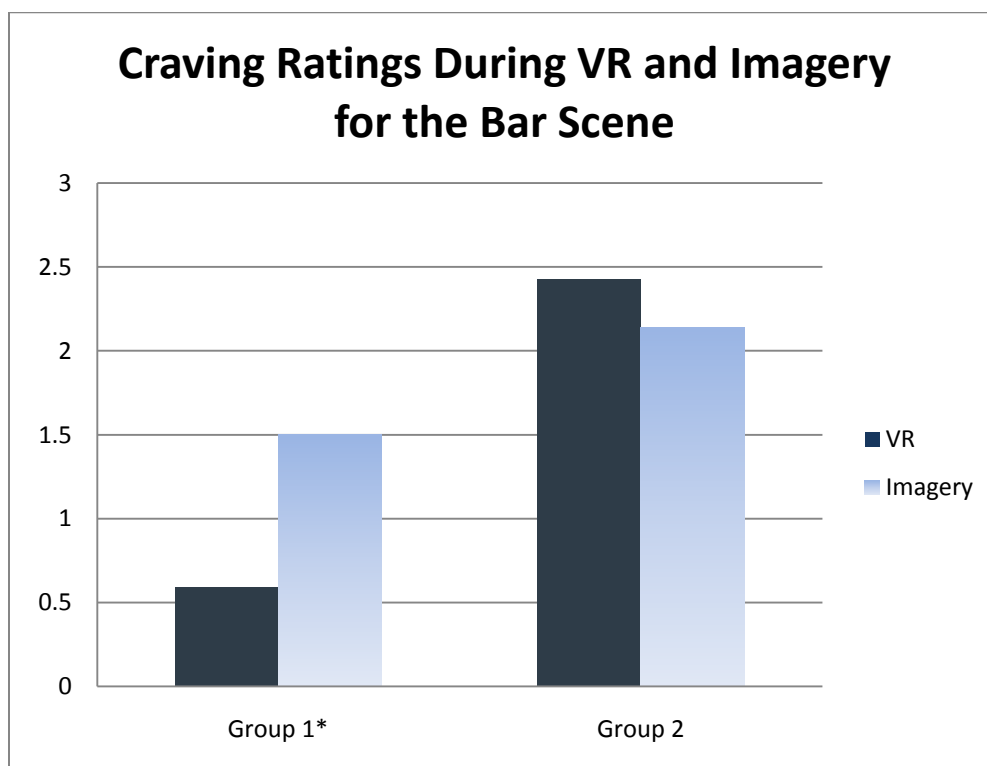
**FIGURE 4: Virtual Reality Baseline**



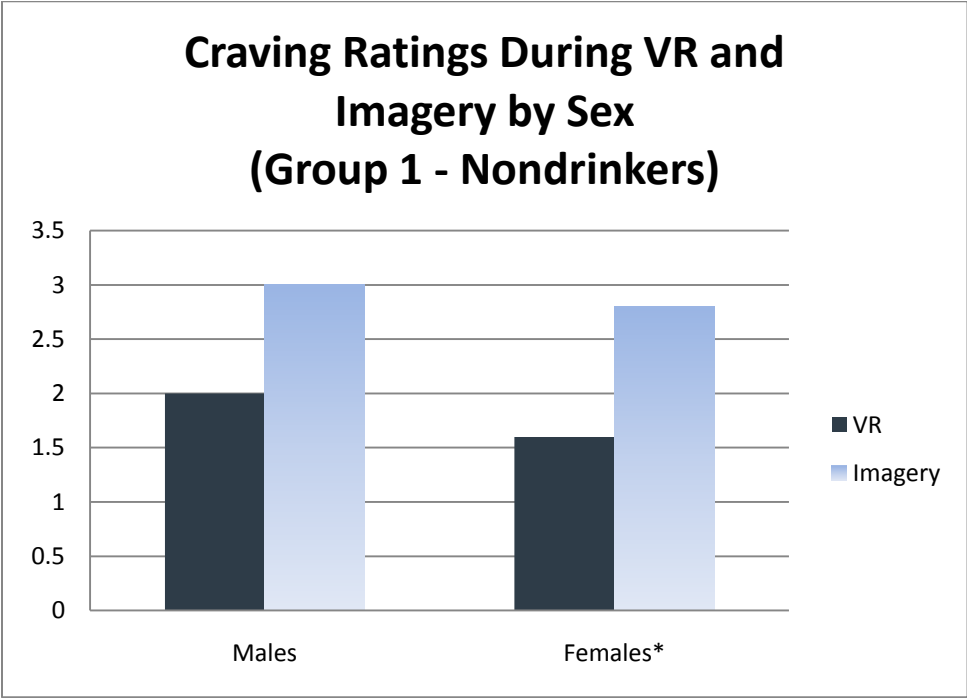
**FIGURE 5: Craving Ratings During Virtual Reality Scenes**



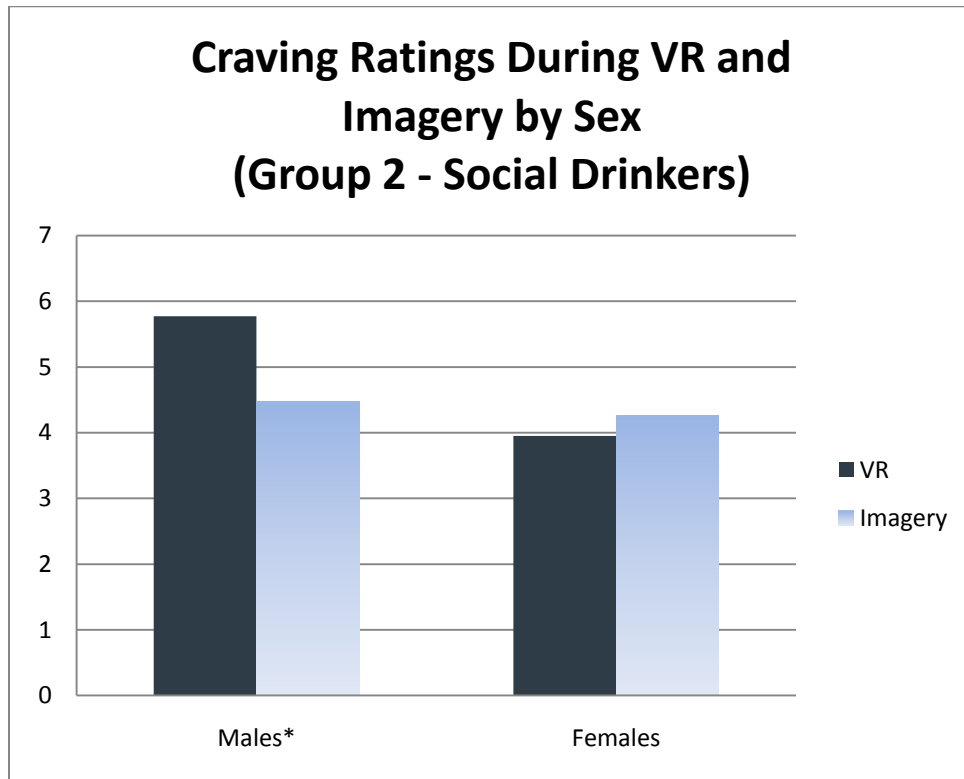
**FIGURE 6: Craving Ratings During VR and Imagery for the Bar Scene**



**FIGURE 7: Craving Ratings During VR and Imagery by Sex**



**FIGURE 8: Craving Ratings During VR and Imagery by Sex (Group 2)**



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## Appendix A: Demographic Information

**Demographic Information**

**Age of Participant**\_\_\_\_\_

**Date of Birth**\_\_\_\_\_

**Sex (*circle one*):** Male    Female

**Marital Status (*circle one*):** Married    Divorced    Widowed    Single

**Current Educational Status (*circle one*):**

High School    Associates    Bachelors    Masters    Doctoral

**Height**\_\_\_\_\_ **Weight**\_\_\_\_\_

**Ethnicity (ex: Caucasian or African American)**\_\_\_\_\_

**Who do you live with:** Alone    With your partner    Roommates    Parents

**How many children do you have:**\_\_\_\_\_

**Employment/Brief Job Description:** \_\_\_\_\_.

**Do you currently suffer from any medical conditions? If so, please list:**\_\_\_\_\_

\_\_\_\_\_.

**Are you currently taking any kind of medication? If so, please**

**list:**\_\_\_\_\_.

**Are you currently receiving psychiatric treatment? If so, please list if you feel comfortable**

**stating why:**\_\_\_\_\_.

**Circle your preferred drink from the following list (*only one*):**

**Dark Beer**

**Red Wine**

**Vodka**

**Gin**

**Scotch**

**White Wine**

**Light Beer**

**Tequila**

## Appendix B: Michigan Alcohol Screening Test

## Michigan Alcohol Screening Test

***Please note: This test will only be scored correctly if you answer each one of the questions.***

**Please check one response for each item.**

1. Do you feel you are a normal drinker? ("normal" - drink as much or less than most other people)?

YES

NO

2. Have you ever awakened the morning after some drinking the night before and found that you could not remember a part of the evening?

YES

NO

3. Does any near relative or close friend ever worry or complain about your drinking?

YES

NO

4. Can you stop drinking without difficulty after one or two drinks?

YES

NO

5. Do you ever feel guilty about your drinking?

YES

NO

6. Have you ever attended a meeting of Alcoholics Anonymous (AA)?

YES

NO

7. Have you ever gotten into physical fights when drinking?

YES

NO

8. Has drinking ever created problems between you and a near relative or close friend?

YES

NO

9. Has any family member or close friend gone to anyone for help about your drinking?

YES

NO

10. Have you ever lost friends because of your drinking?

YES

NO

11. Have you ever gotten into trouble at work because of drinking?

YES

NO

12. Have you ever lost a job because of drinking?

YES

NO

13. Have you ever neglected your obligations, your family, or your work for two or more days in a row because you were drinking?

YES

NO



14. Do you drink before noon fairly often?

YES

NO

15. Have you ever been told you have liver trouble such as cirrhosis?

YES

NO

16. After heavy drinking have you ever had delirium tremens (D.T.'s), severe shaking, visual or

YES

NO

17. Have you ever gone to anyone for help about your drinking?

YES

NO

18. Have you ever been hospitalized because of drinking?

YES

NO

19. Has your drinking ever resulted in your being hospitalized in a psychiatric ward?

YES

NO

20. Have you ever gone to any doctor, social worker, clergyman or mental health clinic for help with any emotional problem in which drinking was part of the problem?

YES

NO

21. Have you been arrested more than once for driving under the influence of alcohol?

YES

NO

22. Have you ever been arrested, even for a few hours, because of other behavior while drinking?

YES

NO

## Appendix C: Timeline Followback

### **TIMELINE FOLLOW BACK**

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
# of	# of	# of	# of	# of	# of	# of
drinks_____	drinks_____	drinks_____	drinks_____	drinks_____	drinks_____	drinks_____
Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs
8	9	10	11	12	13	14
# of	# of	# of	# of	# of	# of	# of
drinks_____	drinks_____	drinks_____	drinks_____	drinks_____	drinks_____	drinks_____
Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs	Over____hrs

## Appendix D: Imagery Scripts

### Script One-Introduction

Hello! Thank you for your interest in participating in this study. This experiment will take approximately one hour. We appreciate you completing all of the surveys and questionnaires. Now sensors will be attached to you hands and arms that will measure your heart rate, skin temperature, and skin conductance during two activities. One of these activities will require you to participate in a virtual reality scenario and the other will ask you to imagine social situations. During this time we will ask you questions about your experience in these situations. Once this has been completed we will remove the sensors and your participation in the experiment will be completed. Please keep in mind that at any time you can leave the experiment for any reason if you do not wish to proceed with no penalties.

### Script Two-Virtual Reality

The assistant will now place the virtual reality goggles on your head. We would like you to keep in mind that you are able to look around and observe your surroundings by moving your head. You will now be led through two scenes.

### Script Three- Imagery Base Line

Imagine you are staring at an aquarium. All around you, you see tropical fish bursting with bright colors. You hear the gentle sounds of water slowly streaming as you watch the fish swim.

### Script Four-Imagery

The assistant will now play a recording for you where you are asked to imagine yourself in scenarios from your past.

### Imagery Bar Script

Take three deep breaths, in through your nose and out of your mouth. Now sit back and rest your eyes and relax your body. Now imagine you are getting ready for a night out with your friends. Imagine yourself going through the motions, showering, picking out your clothes, and deciding who is going to drive. Now think about any drinking you and your friends may do prior to leaving. Put yourself in the mindset of how you feel when you are on your way out. Now imagine yourself entering your favorite drinking spot. The smells you usually smell the people you usually see the sounds you usually hear. Now picture your self walking towards the bar and approaching the bartender. Do you usually order a drink as soon as you get to the bar? Or do you wait a little bit? What is going through your mind? How much do you plan on drinking? You order your favorite drink. How does the drink feel in your hand? Does it feel familiar in your hand? How does that first sip taste? After that first sip do you decide to drink more? For the next minute or so continue the night in your mind, how events usually unfold, how much you generally drink, and how you feel by the time the night is over.

### Imagery Kitchen Script

Take three deep breaths, in through your nose and out of your mouth. Now sit back and rest your eyes and relax your body. Now imagine you're at a party with all of your friends. You're hanging out making conversation with your friends while people dance around you and you hear music in the background. You decide to get a drink. Now imagine yourself walking into the kitchen at the party. What do you expect to see and you push the door open? As you walk in you see the countertops lined with alcoholic beverages. From liquor to beer to wine, nearly every possible drink choice is available to you. As your eyes gaze through the room you begin to

become strangely thirsty and eagerly make the decision to have your favorite drink. Once you make that drink for yourself do you linger longer in the kitchen, perhaps thinking about your next drink choice or do you return to your friends instead. As you sip your drink how do you feel? Do you continue to sip your drink or do you decide to finish it quickly in order to get another one? For the next minute or so continue the night in your mind, how events usually unfold, how much you generally drink, and how you feel by the time the night is over.